

## CLAIMS

We claim:

- 5           1.     A monitor substrate for measuring an ion-implantation ion  
energy and dosage comprising:  
  
                  a thin film supported on said monitor substrate wherein  
                  said thin film having an optical characteristic that is  
                  sensitive to said ion-implantation damage as described by  
10             implant dose and implant energy.
2.     The substrate of claim 1 wherein:  
  
                  said thin film having a reflectivity that is sensitive to said  
15             ion-implantation damage.
3.     The substrate of claim 1 wherein:  
  
                  said thin film comprising a mixture of dye molecules with  
20             weak covalent bonds sensitive to said ion-implantation  
energy and dosage in a polymer matrix suitable for wafer-  
coating.
4.     The substrate of claim 3 wherein:  
  
                  said mixture of a dye with a weak covalent bond having a  
25             heterogeneous-cleavage property that is sensitive to said  
ion-implantation energy and dosage.
5.     The substrate of claim 4 wherein:  
  
                  said dye mixture has an optical property of changing from  
30             transparent to colored upon heterogenous-cleavage.

6. The substrate of claim 1 wherein:

said monitor substrate is a silicon substrate, which may have a thin oxide coating.

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7. The substrate of claim 1 wherein:

said thin film having a thickness ranging substantially from one micrometer to twenty micrometers.

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8. An apparatus for measuring an ion-implantation dosage comprising:

a scanning densitometer for measuring reflected light from a monitor substrate; and

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a thin film supported on said monitor substrate wherein said thin film having an optical characteristic that is sensitive to said ion-implantation.

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9. The apparatus of claim 8 further comprising:

a light source for projecting measuring beam onto said monitor substrate for generating a reflected light.

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10. The apparatus of claim 9 further comprising:

a bare silicon substrate for measuring a full scale reflected light represented by  $I_0$  reflected from said bare silicon substrate with said light source projecting a full scale light onto said bare silicon substrate.

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11. The apparatus of claim 10 further comprising:

a light source control means for controlling said light source to project said full scale light onto a plurality of points on said monitor substrate before and after an ion implantation for obtaining reflectances  $I'$  and  $I''$  respectively at each point.

12. The apparatus of claim 10 further comprising:

an ion-implantation measurement controller for controlling said apparatus and for calculating said implantation ion energies and dosage from said reflected light from said monitor substrate.

13. The apparatus of claim 8 wherein:

said thin film having a reflectivity that is sensitive to said ion-implantation ion energy and dosage.

14. The apparatus of claim 8 wherein:

said thin film comprising a mixture of a dye with a weak covalent bond that is sensitive to said ion-implantation damage and a polymer matrix suitable for wafer-coating.

15. The apparatus of claim 10 wherein:

said mixture of a dye with a weak covalent bond having a heterogeneous-cleavage property that is sensitive to said ion-implantation ion energy and dosage.

16. The apparatus of claim 8 wherein:

said monitor substrate is a silicon substrate.

17. The apparatus of claim 8 wherein:  
said monitor substrate is a silicon substrate with a thin  
oxide coating of 50 to 5000 angstroms.
- 5 18. The apparatus of claim 8 wherein:  
  
said thin film having a thickness ranging substantially from  
a micrometer to twenty micrometers.
- 10 19. A method for measuring an ion-implantation ion energy  
and/or dosage comprising:
- 15 a) measuring a full scale reflection, represented by  $I_o$ , by  
projecting a full scale light onto a bare silicon;
- b) performing a pre-implant reflection measurement by  
projecting said full scale light onto a plurality of points on a  
monitor substrate having a thin film supported on said  
20 monitor substrate with said thin film having an optical  
characteristic that is sensitive to said ion-implantation-  
dosage producing optical intensities  $I'$ ; and
- 25 c) performing an ion implantation and then performing a  
post-implant reflection measurement by projecting said full  
scale light onto said plurality of points on said monitor  
substrate to obtain a set of reflection intensities,  $I''$ , for each  
of said points on said monitor substrate for calculating an  
ion-implantation energy and/or dosage profile.
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20. The method of claim 19 wherein:

5       said step c) of obtaining a set of reflection intensity differences for each of said plurality of point on said monitor substrate is a step of calculating a logarithmic value for a ratio of  $I'$ , a reflection intensity before, and  $I''$ , a reflection intensity after said step of ion implantation.

21. The method of claim 19 wherein:

10       said step c) of obtaining a set of reflection intensity differences for each of said plurality of point on said monitor substrate is a step of calculating a ratio of a reflection intensities before and after said step of ion implantation.

22. The method of claim 19 wherein:

15       said step c) of obtaining a set of reflection intensity differences for each of said plurality of point on said monitor substrate is a step of calculating the arithmetic differences between reflection intensities before and after said step of ion implantation.

23. A method for measuring an ion-implantation energy and/or dosage comprising:

25       a) forming a thin film with an optical characteristic sensitive to an ion-implantation dosage; and

30       b) measuring a change of said optical characteristic after an ion implantation for calculating said ion implantation energy and/or dosage.